Retrospective on Cooperative Research Efforts Between the Chinese Academy of Sciences and DOE's Carbon Dioxide Information Analysis Center (CDIAC): 1984-2003

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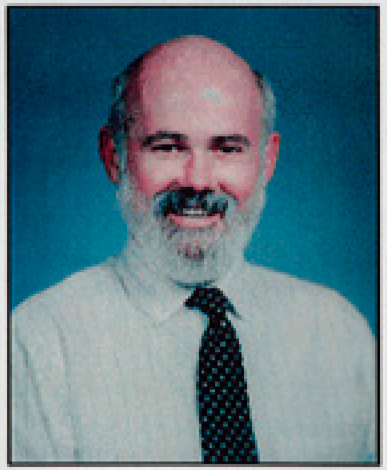
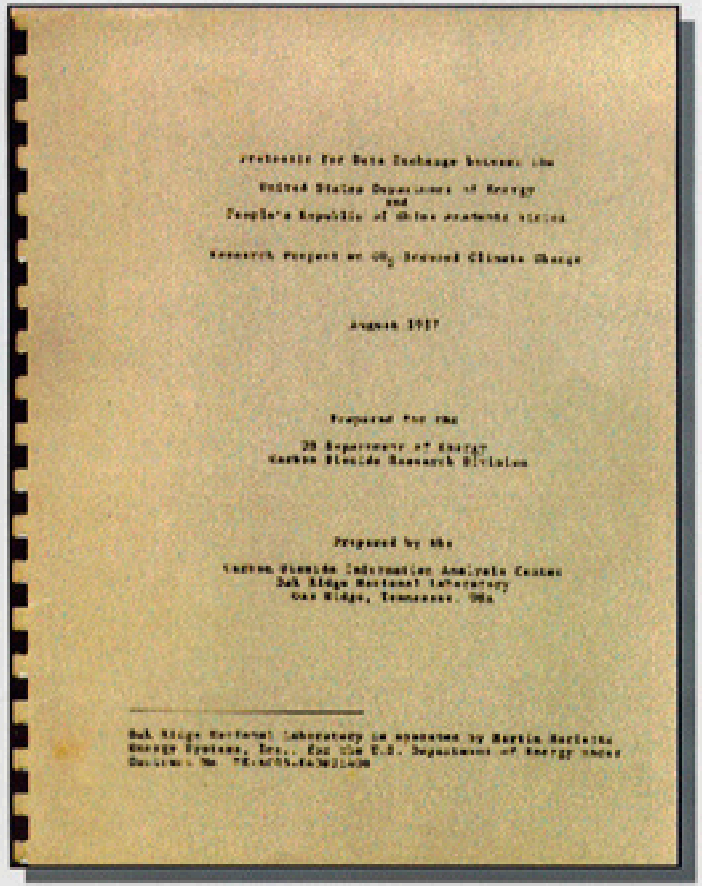
CDIAC Roles in DOE-CAS Joint Research

- **Computing systems**
- **Data quality assurance, documentation, and publication**
- **Data analysis**
- **Data exchange**
- **Project summary and bibliography publication**
- **Visitor exchange**

Protocols for Hardware, Software, Data Management

- **Paul Kanciruk and Michael Farrell (1987)**





Protocols for Data Exchange between the

United States Department of Energy
and
People's Republic of China Academia Sinica

Research Project on CO_2 Induced Climate Change

August 1987

Prepared for the

US Department of Energy
Carbon Dioxide Research Division

Prepared by the

Carbon Dioxide Information Analysis Center
Oak Ridge National Laboratory
Oak Ridge, Tennessee, USA

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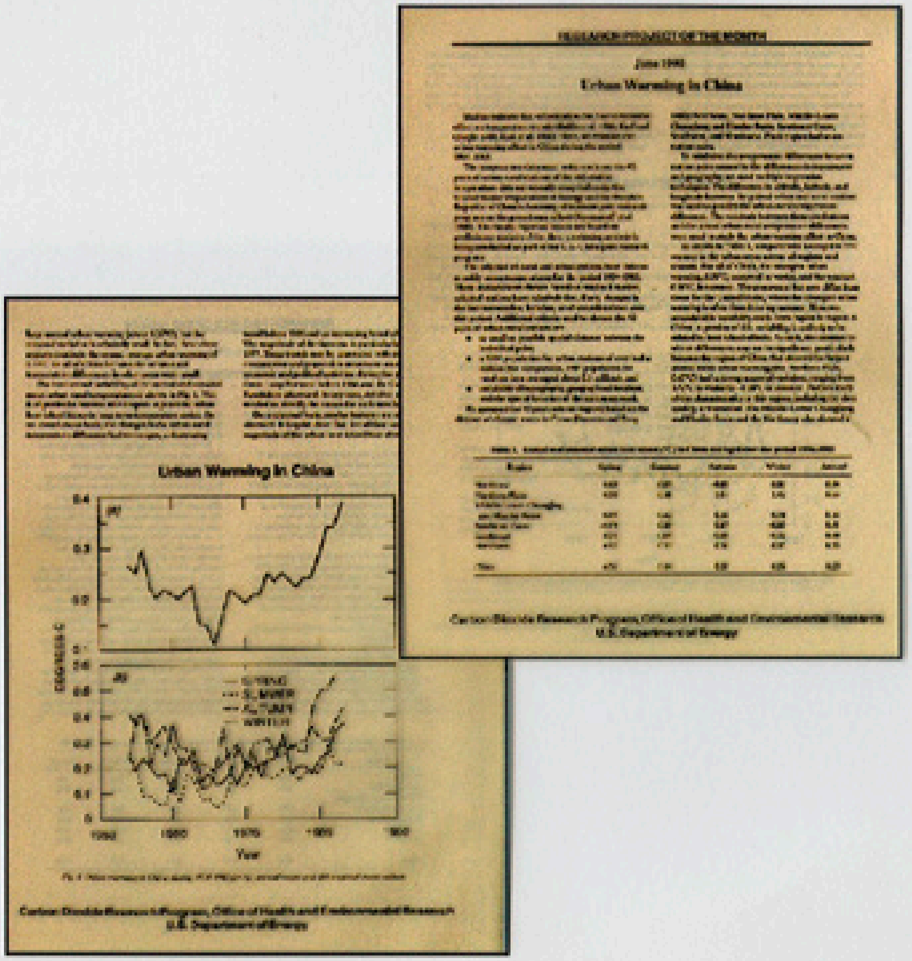
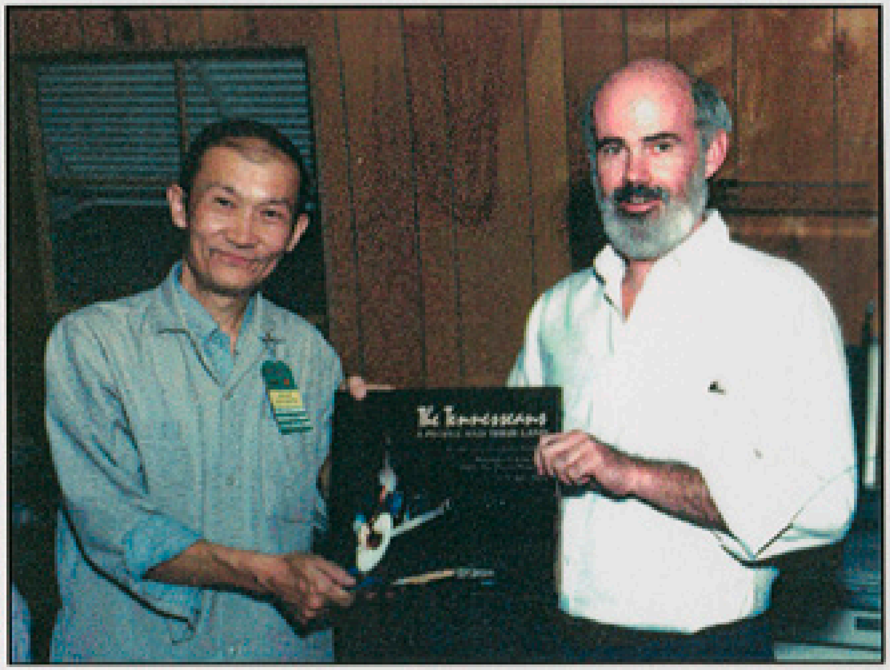
Urban Warming In China (Research Project of the Month)

- Wei-Chyung Wang, Zeng Zhaomei, and Thomas Karl
- Published June 1990
- Average urban warming of 0.23°C across all regions and seasons during the period 1954-1983
- Strongest urban warming in winter
- Considerable variability among regions
- Decreasing trend before 1966, then an increasing trend



CAS Visitors to CDIAC

- Zhang Peiyuan (Institute of Geography) - 1985
- Wang Xiao-Bai (Institute of Atmospheric Physics) - 1988-89

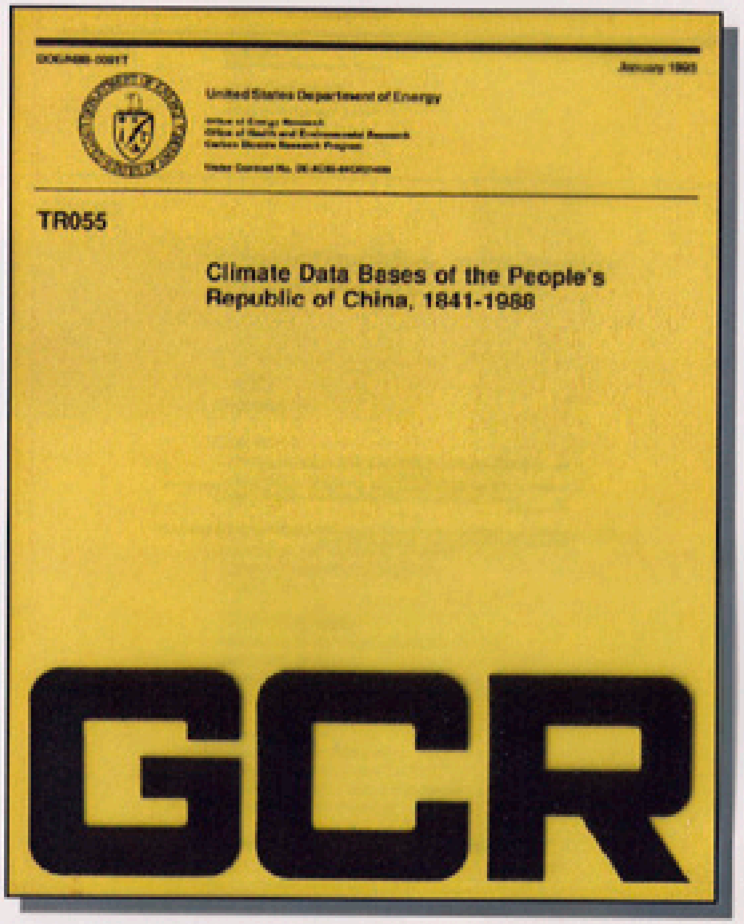


Two Long-Term Instrumental Climatic Data Bases of the People's Republic of China (CDIAC NDP-039)

- Tao Shiyan, Fu Congbin, Zeng Zhaomei, and Zhang Qingyun (Institute of Atmospheric Physics)
- First published 1991, updated 1997
- Data through 1993 from 267 stations
- Some data from before 1900

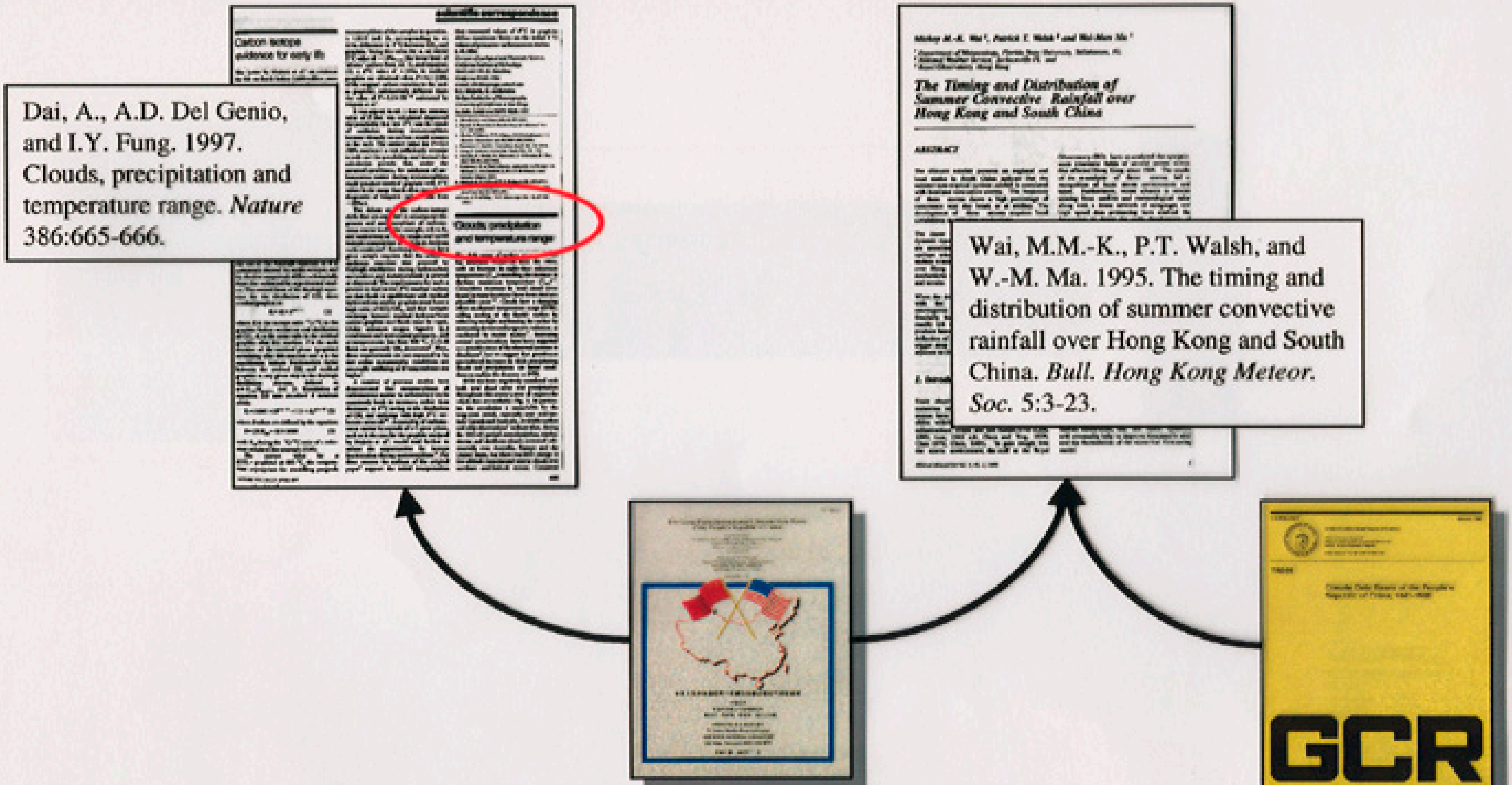
Climate Data Bases of the People's Republic of China, 1841-1988 (DOE TR055)

- **Dale Kaiser, Tao Shiyan, Fu Congbin, Zeng Zhaomei, and Zhang Qingyun (Institute of Atmospheric Physics), Wei-Chyung Wang, and Thomas Karl**
- **Published 1993**
- **Data from 296 stations, organized into 5 data sets**



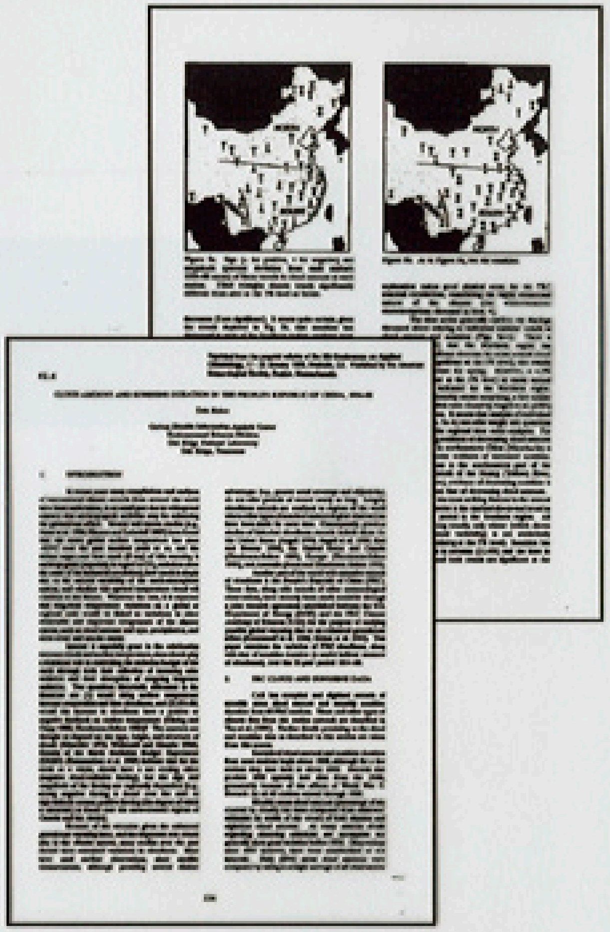
CDIAC

Citations of Chinese Data



Analysis of Chinese Cloud & Sunshine Data

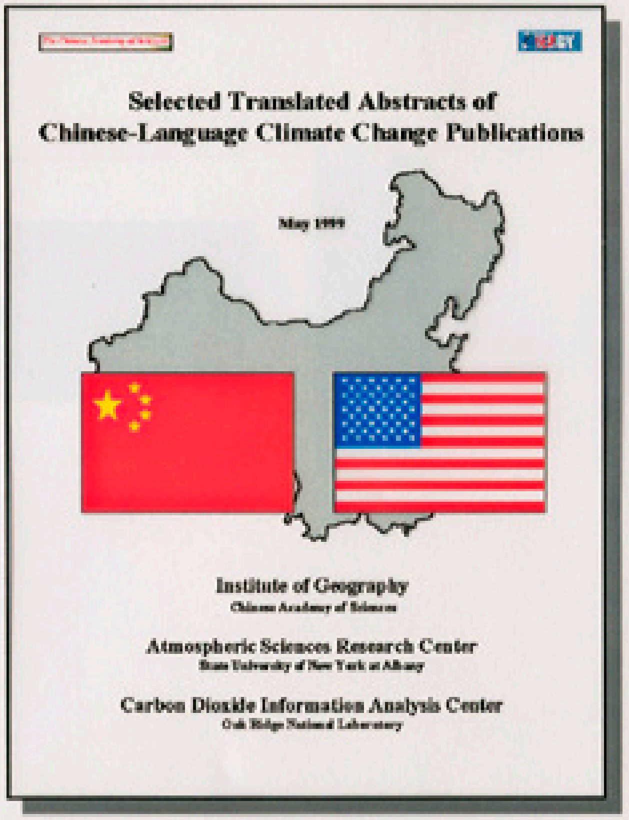
- **Based on data in NDP-039 (Tao et al.)**
- **Significant 10.9% decrease in annual mean sunshine for the region as a whole, and an nonsignificant 2.6% decrease in mean annual cloud amount, over the period 1954-1988**
- **Sunshine decrease was driven by a large decrease in southern China, especially in autumn (21.4%)**
- **Decreasing sunshine not coupled with increasing cloud amount could be explained by changing cloud climatology**



Kaiser, D.P. 1993. Cloud amount and sunshine duration in the People's Republic of China, 1954-88, p. 224-32, IN *Proceedings, Eighth Conference on Applied Climatology*. American Meteorological Society, Boston.

Bibliography of Chinese Climate-Change Literature

- Published 1999
- Collaboration between Institute of Geography, Atmospheric Sciences Research Center, and CDIAC
- Translated abstracts from 1995-1998
- Adaptation, ancient climate change, climate variation, the East Asia monsoon, historical climate change, impacts, modeling, and radiation and trace-gas emissions



Selected Translated Abstracts of Chinese-Language Climate Change Publications

May 1999

Institute of Geography
Chinese Academy of Sciences

Atmospheric Sciences Research Center
State University of New York at Albany

Carbon Dioxide Information Analysis Center
Oak Ridge National Laboratory

徐国昌. 1995. 绿洲气候资源和绿洲建设. 干旱区资源与环境, 9(4):138-145

Xu Guochang. 1995. Climatic resources and oasis construction. Journal of Arid Land Resources and Environment 9(4):138-145.

本文根据绿洲气候资源的两重性及其变化趋势, 讨论了绿洲气候生态的巨大潜力与生态环境的脆弱性, 并提出绿洲开发对策。

关键词: 绿洲 气候资源 绿洲建设

The dual nature of the climatic resources of oases and their tendency to change are analyzed in the paper. The author discusses the great climate production, the latent capacity, and the fragile ecological environment of oases. According to the features of the oasis climatic resources, some strategies for oasis development are suggested.

Keywords: oasis, climatic resources, oasis construction

Ancient Climate Change

吴胜光, 韩辉友, 俞锦标. 1995. 贵州晴隆碧痕营晚第四系及古环境研究. 地理研究, 14(2):49-55

Wu Shengguang, Han Huiyou, and Yu Jinbao. 1995. Analysis of the Late Quaternary sediments and paleoenvironment in Bihenying, Qinglong County, Guizhou Province. Geographical Research 14(2):49-55.

本文对贵州晴隆碧痕营湖相发育的晚第四系的古环境作出了分析, 距今3万—2万年前后的温暖期, 洼地附近的山地上生长着以落叶阔叶为主的针阔混交林, 小有波动, 当时的年均温较现在低1—6°C; 在气温较今约低2—6°C距今3—2.6万年前后, 是含高比例水青冈的针阔混交林, 在距今2.3万年前后, 气温较今低1—3°C, 附近山地生长常绿阔叶、落叶混交林; 在距今2.6-2.3万年和距今2.3万年以后一段时期, 针阔混交林发育; 在向冰期转化过程中, 气候干冷, 蕨类植物蔓生; 湖相层之后是混杂泥砾堆积。

关键词: 碧痕营 晚第四系 古环境 孢粉

The paper presents an analysis of the ancient environment of lacustrine deposit formed in the Late Quaternary in Bihenying, Qinglong County, southwest Guizhou Province. From 30 ka BP to 20 ka BP, the annual mean temperature was 1-6°C lower than that of today, mixed deciduous broadleaf and coniferous forests were growing on the hill land, with little variation between deciduous broadleaf forest and mixed coniferous forests. From 30 ka BP to 26 ka BP, the annual mean temperature was 2 to 6°C lower than that of today and there were mixed deciduous broadleaf and coniferous trees with a high proportion of Fagus. Around 23 ka BP, the temperature was 1-3°C lower than that of today, and there were mixed deciduous and evergreen trees. From 26 ka BP to 23 ka BP, and after 23 ka BP, the mixed broadleaf and coniferous forests were growing there. After that period, the climate turned dry and cold and pteridophyte grew widely. In the full glacial period, lacustrine deposition stopped and was replaced by the chaotic sediments of mud and gravel.

Keywords: Bihenying, Late Quaternary system, Paleoenvironment, pollen and spore

GEOPHYSICAL RESEARCH LETTERS, VOL. 25, NO. 19, PAGES 3599-3602, OCTOBER 1, 1998

Analysis of total cloud amount over China, 1951-1994

Dale P. Kaiser
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Abstract. Trends in Chinese total cloud amount were analyzed for the period 1951-1994. Cloud data were obtained from a database of 6-hourly weather observations provided by the China Meteorological Administration (CMA) to the U.S. Department of Energy's Carbon Dioxide Information Analysis Center (CDIAC) through a bilateral research agreement. Seasonal and annual means of *midday* (1400 Beijing Time (BT)) and *midnight* (0200 BT) observations were computed for each of 196 stations and over 8 specific regions of China. Linear regression analysis was used to characterize seasonal and annual trends in total cloud amount from 1951-1994. Decreasing trends in both midday and midnight cloud amount are observed over much of China; most stations in central, eastern, and northeastern China show statistically significant decreases of 1-3% sky cover per decade. These decreases in cloud amount are especially interesting in light of recent temperature trends observed over China. Several studies have shown significant *increasing* trends in daily minimum temperatures over China since 1951, especially in the northeastern part of the country, precisely where the strongest decreasing trends in total cloud amount are observed. Increases in cloud amount have been offered as a possible explanation for increasing minimum temperatures in other parts of the world; however, in China it seems that some mechanism(s) other than increasing cloud amount must be considered for understanding the observed increase in minimum temperatures.

Introduction

The distribution of clouds over the globe greatly influences the regimes of other important climatic variables, such as temperature and precipitation. While satellite records of cloudiness are extremely valuable in the study of the earth's climate (spanning now 2-3 decades), the longer records of surface-observed cloudiness for much of the earth's surface are preferred for integration with long-term records of other surface variables in attempting to understand these variables' relationships and trends.

As databases of surface-based cloud observations have become available for research over recent decades, there have been many studies concerned with examining trends in regional cloud cover [e.g., [*Kaiser and Razuvaev*, 1995] for the former Soviet Union, [*Angell*, 1990] for the United States, [*Henderson-Sellers*, 1986] for Europe, [*Jones and Henderson-Sellers*, 1986] for Australia, and [*Kaiser and Vose*, 1997] for China]. The findings of [*Kaiser and Vose*, 1997] differ from the other studies in that China appears to have experienced decreased cloudiness over recent decades, whereas the other land regions show evidence of increasing cloud cover. [*Kaiser and Vose*, 1997] performed a gridded analysis of variations and trends in cloud amount using 187 Chinese weather stations for the period 1954-1990. The main findings were significant decreases in annual mean cloud amount over much of northern China, coupled with corresponding increases in the frequency of occurrence of clear skies. The decreasing trends in annual mean cloud amount over northern China were found to be driven by decreasing cloud amount over most months of the year. The current study uses an expanded period of record of China cloud observations (1951-1994) from basically the same station network to reexamine trends in cloud amount at individual stations and over eight regions of China.

Data

The cloud data analyzed here were extracted from a database of 6-hourly weather observations provided by the China Meteorological Administration (CMA) to the U.S. Department of Energy's Carbon Dioxide Information Analysis Center (CDIAC) through a bilateral research agreement. Six-hourly observations [0200, 0800, 1400, and 2000 Beijing Time (BT)] of cloud amount (0-10 tenths of sky cover) are available from 196 Chinese stations covering the period 1954-94. From 1951-1953, however, only 0800, 1400, and 2000 BT observations were made, and it is for this reason that [*Kaiser and Vose*, 1997] began their analysis in 1954, as they chose to use evenly-spaced observations from throughout the 24h day. In this analysis, a slightly different approach to data sampling will be taken, which is detailed in the following section.

Analysis Procedure

Since it has long been recognized that it is much more difficult to accurately estimate cloud amount at night (e.g., [*Schneider*, 1972]), especially if thin cirrus clouds are present, this study analyses daytime observations separately from nighttime observations. Daytime analysis is for the period 1951-1994 and the nighttime analysis is for 1954-1994 (because of the lack of 0200 BT observations prior to 1954). One would expect observed daytime and nighttime cloud amount to differ, not only because the presence of clouds is easier to detect in daylight, but due to the diurnal variations typically observed over land for specific cloud types [e.g., cumulus cloud amount over China typically peaks in the early afternoon across all seasons [*Warren et al.*, 1986]]. Such day/night differences in cloud amount are of interest in this work, but do not present any difficulties for the main objective, which is to characterize trends in cloud amount.

An additional caveat pertaining to the cloud data involves the 0200 BT observations from 1954-1960. [*Wang et al.*, 1984] indicates that some 0200 BT values of cloud

Paper number 98GL52784.
0094-8534/98/98GL-52784$05.00

GEOPHYSICAL RESEARCH LETTERS, VOL. 27, NO. 15, PAGES 2193-2196, AUGUST 1, 2000

Decreasing cloudiness over China: An updated analysis examining additional variables

Dale P. Kaiser
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Abstract. Trends in Chinese total cloud amount, surface air pressure, surface water vapor pressure, and surface relative humidity were analyzed for the period 1954–1994. The data were obtained from a database of 6-hourly weather observations provided by the China Meteorological Administration. Seasonal and annual means of all four variables were computed for each of 196 stations and for China as a whole. Linear regression analysis was used to characterize seasonal and annual trends in these variables from 1954–1994, with the cloud amount record also extended through 1996 using a newly compiled global cloudiness database. Decreasing cloud amount trends are observed over much of China, as are increasing trends in surface air pressure. The spatial pattern of observed trends in water vapor pressure and relative humidity are more complex; a few scattered regions of China show increasing surface water vapor pressure, whereas surface relative humidity is found to increase in northwestern China and decrease in northeastern China (where the largest decreases in cloud amount are observed). The all-China time series of total cloud amount (surface air pressure) shows a remarkable drop-off (upswing) beginning in 1978.

1. Introduction

As preparation of the Intergovernmental Panel on Climate Change's Third Assessment Report takes place, one of the most important climate variables of interest—from both historical and future scenario standpoints—is cloud amount. For several nations of the world, there exist records of surface-observed cloud amount dating back to the middle of the 20th Century or earlier, offering valuable information on variations and trends. Studies using such databases include *Sun and Groisman* [2000] and *Kaiser and Razuvaev* [1995] for the former Soviet Union, *Angell* [1990] for the United States, *Henderson-Sellers* [1986] for Europe, *Jones and Henderson-Sellers* [1992] for Australia, and *Kaiser* [1998] for China. The findings of *Kaiser* [1998] differ from the other studies in that much of China appears to have experienced decreased cloudiness over recent decades (1954–1994), whereas the other land regions for the most part show evidence of increasing cloud cover over those areas that exhibit any significant long-term trends. This paper expands on *Kaiser* [1998] by analyzing trends in additional surface-observed meteorological variables for China [station pressure (p), water vapor pressure (e), and relative humidity (f)] and extending the total cloud amount (N) analysis an additional two years (through 1996).

Paper number 2000GL011358.
0094-8276/00/2000GL011358$05.00

2. Data

The China meteorological data analyzed here were extracted from a database of 6-hourly weather observations provided by the China Meteorological Administration (CMA) to the Carbon Dioxide Information Analysis Center at Oak Ridge National Laboratory via a bilateral research agreement between the CMA and the U.S. Department of Energy. Six-hourly observations [0200, 0800, 1400, and 2000 Beijing Time (BT)] of N (tenths of sky cover), p (tenths of hPa), e (tenths of hPa), and f (whole percent) are available from 196 stations covering the period 1954–94. In addition to the observations of N through 1994 from the CMA database, 6-hourly observations of N for 190 of the 196 CMA stations were obtained from the database of *Hahn and Warren* [1999] for 1995 and 1996.

3. Analysis Procedure

The analysis of N carried out in *Kaiser* [1998] used only "midday" observations (1400 BT), since it has long been recognized that it is much more difficult to accurately estimate cloud amount at night (e.g., [*Schneider*, 1972]), especially if thin cirrus clouds are present. While this is probably the best approach to use in independently examining long-term changes in N, the present analysis seeks to directly compare changes in several other variables and take advantage of as many observations of p, e, and f as possible; therefore, for all four variables analyzed here, all four 6-hourly observations from each day were used. In fact, this is not thought to be a serious problem for analysis of N, since *Kaiser* [1998] found similar long-term trend results for midday and "midnight" (0200 BT) observations over China.

In order to screen for inhomogeneities in the station records of p, e, and f, time series of annual means in these variables over 1954–1994 were constructed and examined graphically. (Most of the CMA stations do not have detailed station histories currently available for research use.) Those stations' records displaying any obvious jumps in any of these variables were excluded from the analysis of p, e, and f (resulting in 162 stations being retained for these variables). Step-like changes in the p time series for most of the 34 rejected stations implied station moves that likely resulted in at least one significant change in station elevation over the period of record. *Kaiser* [1998] found no obvious problems of this type when screening time series of N; therefore, all station records were used for this variable. It seems that the nature of any station moves typically did not affect visual estimates of N made by human observers, as no obvious stepwise changes are observed in N for any of the stations analyzed.

The 6-hourly observations of all four variables were averaged for each station over the four traditional meteorological

Decreasing trends in sunshine duration over China for 1954–1998: Indication of increased haze pollution?

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Yun Qian

Pacific Northwest National Laboratory, Richland, Washington, USA

Received 5 August 2002; revised 2 October 2002; accepted 7 October 2002; published 15 November 2002.

[1] Analysis of meteorological data made available by the China Meteorological Administration (CMA) reveals significant decreases in sunshine duration over the latter half of the 20th century over much of China, especially in the eastern half of the country. Most of the decrease has occurred since about 1980, and appears to be related to large increases in atmospheric anthropogenic aerosol loading that have increased the aerosol extinction coefficient (AEC), as calculated from observations of (decreasing) visual range. A finding of particular interest is a significant decrease in summertime maximum temperature over this time period for a large portion of southeastern China near the Sichuan Basin (while the rest of China—and indeed most of the northern hemisphere—has warmed). This same region of southeastern China shows the largest decreases in sunshine duration and largest increases in AEC. The consistent spatial and temporal patterns of change in these variables seem to support the theory that aerosol loading has decreased the duration and intensity of sunshine in this region and thus lowered summertime maximum temperatures. *INDEX TERMS:* 0305 Atmospheric Composition and Structure: Aerosols and particles (0345, 4801); 0345 Atmospheric Composition and Structure: Pollution—urban and regional (0305); 1610 Global Change: Atmosphere (0315, 0325); 3359 Meteorology and Atmospheric Dynamics: Radiative processes; 3399 Meteorology and Atmospheric Dynamics: General or miscellaneous. **Citation:** Kaiser, D. P., and Y. Qian, Decreasing trends in sunshine duration over China for 1954–1998: Indication of increased haze pollution?, *Geophys. Res. Lett.*, *29*(21), 2042, doi:10.1029/2002GL016057, 2002.

1. Introduction

[2] Analyses performed in recent years have shown that temperatures over much of China, more remarkably over northern China, have increased over the last half of the 20th century, similar to most locations with adequate observational data [*Wang and Gaffen*, 2001; *Wang and Gong*, 2000]. Most of this observed increase has been due to increases in daily minimum temperatures [*Karl et al.*, 1993; *Easterling et al.*, 1997]. However, several studies have shown that some regions of China, most notably the Sichuan Basin, have experienced statistically significant cooling trends [*Li et al.*, 1995; *Qian and Giorgi*, 2000]. This cooling trend is mainly driven by the decrease of daily maximum temperature [*Qian et al.*, 1996]. The comprehensive analysis of aerosol pollutant data and climatic variables indicate a consistent picture of increasing emission of aerosol precursors, resulting in increasing aerosol amounts, negative radiative forcing and surface cooling [*Qian and Giorgi*, 2000; *Xu*, 2001]. A series of numerical modeling efforts has further confirmed these physical relationships [*Qian and Giorgi*, 1999; *Giorgi et al.*, 2002].

[3] The duration of sunshine, defined as the amount of time the disk of the sun is above the horizon and not obscured by naturally occurring obstructions such as clouds, fog, and haze, is one of the oldest types of radiation measurements. Meteorological observing stations in China have employed the Campbell-Stokes Sunshine Recorder since 1954 [*Kaiser et al.*, 1993]. Prior to 1954, the Jordan Photographic Sunshine Recorder was used. The quantity measured by a sunshine recorder is the amount of time, usually expressed to the nearest 0.1 hour, in which the direct solar radiation is of sufficient intensity to activate the recorder. A rough approximation of the amount of energy in the direct beam necessary to activate the recorder is 0.12 cal cm^{-2} min^{-1} [*Coulson*, 1975]. The fraction of maximum possible sunshine for one day is therefore determined by the intensity of direct solar radiation, which is sensitive to and frequently perturbed by clouds and haze, especially during wintertime or early and late in a day when the atmospheric optical path is longer.

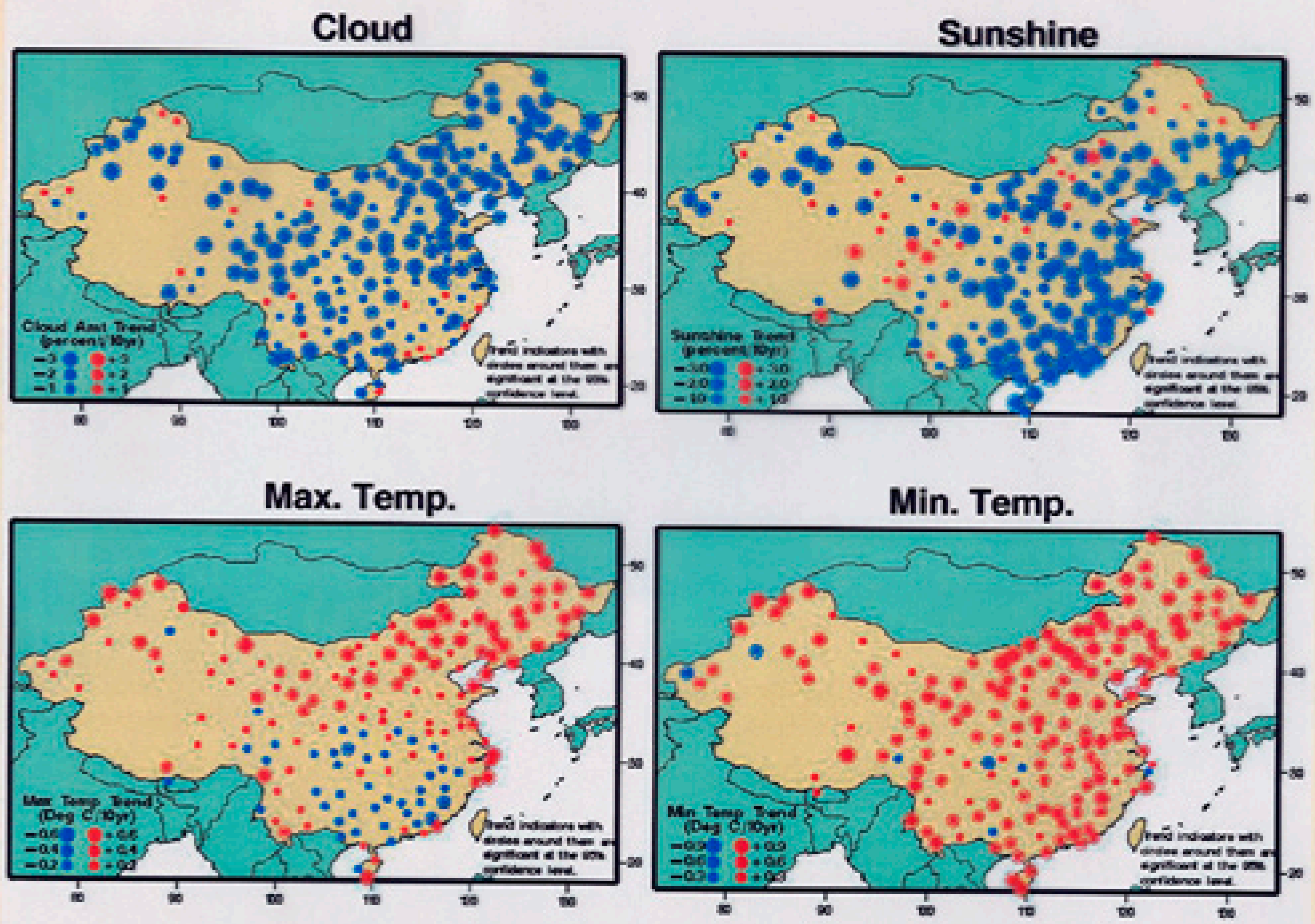
[4] The sunshine duration record for China (described below), which covers most of the last half of the 20th century, should be useful in detecting the long-term variation of the aerosol effect and may help in understanding observed changes of the daily maximum temperature and atmospheric aerosols. In this paper we employed records of sunshine duration, temperature, and aerosol data over China to analyze temporal trends and spatial patterns of these variables so as to reveal possible relationships in the data.

2. Data and Analysis Procedure

[5] The China meteorological data analyzed in this study were made available to the U.S. Department of Energy's Carbon Dioxide Information Analysis Center (CDIAC) at Oak Ridge National Laboratory by colleagues from the China Meteorological Administration (CMA) via a bilateral research agreement between the two national agencies. These data consist of daily maximum (Tmax) and minimum

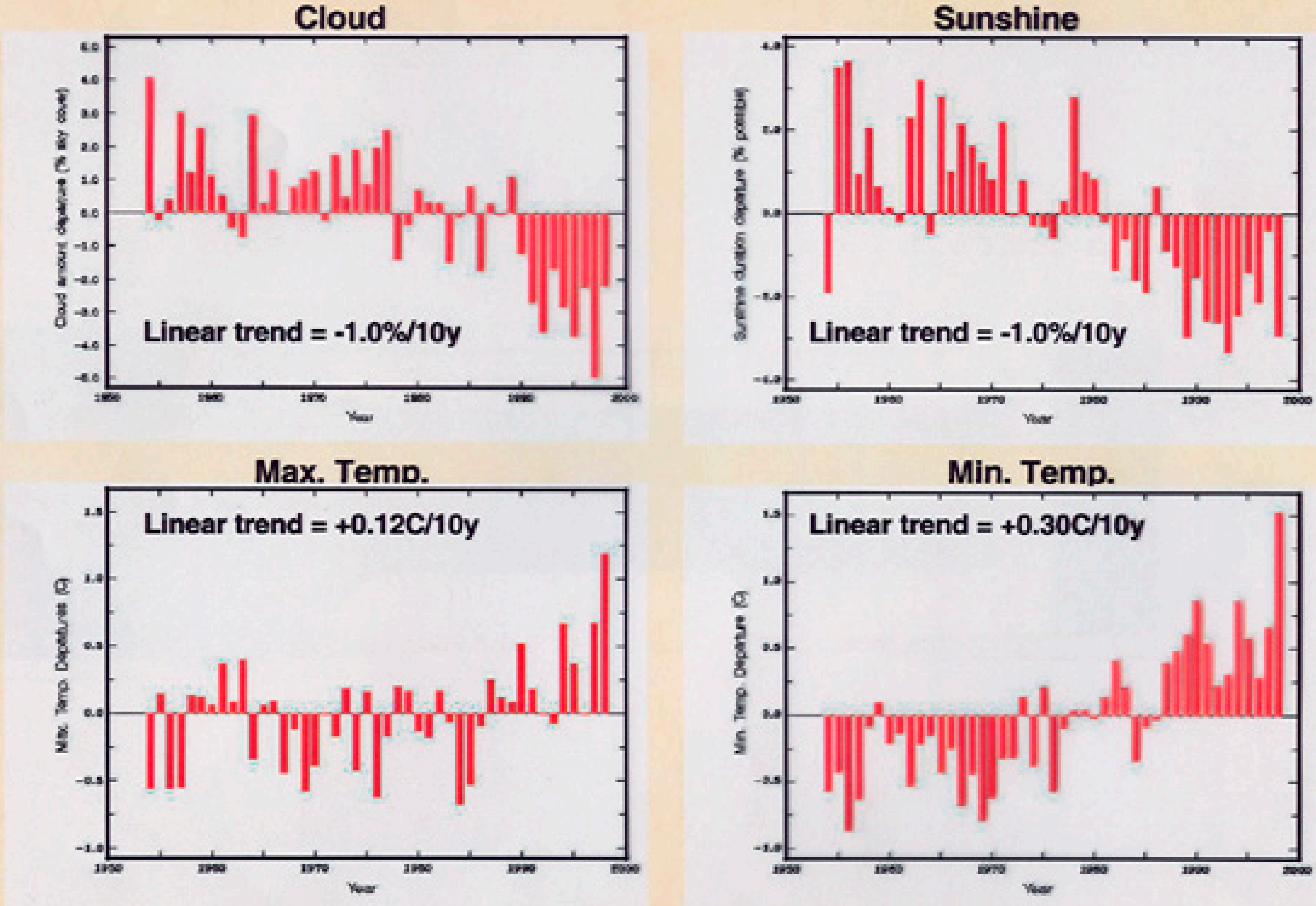
Retrospective on Cooperative Research Efforts Between the Chinese Academy of Sciences and DOE's Carbon Dioxide Information Analysis Center (CDIAC): 1984–2003

Annual Station Trends of Cloud, Sunshine, Tmax, and Tmin (1954–1998)



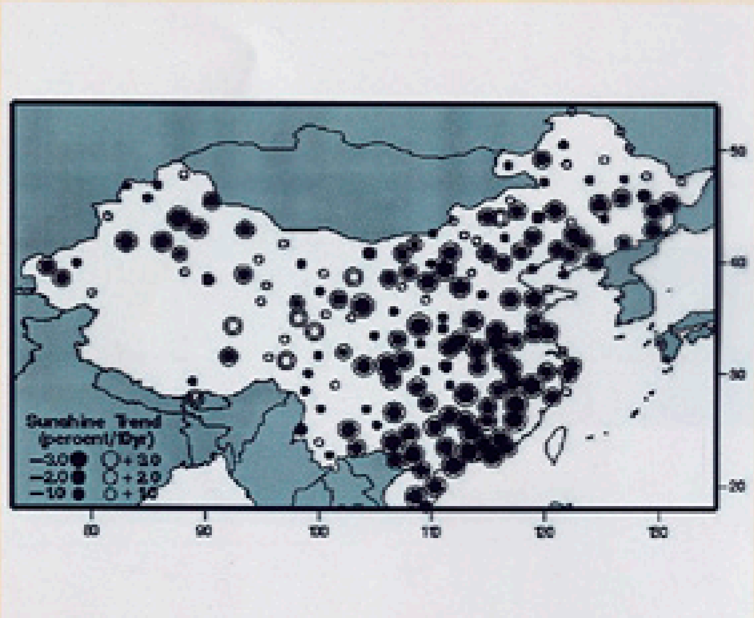
Retrospective on Cooperative Research Efforts Between the Chinese Academy of Sciences and DOE's Carbon Dioxide Information Analysis Center (CDIAC): 1984–2003

Annual Station Trends of Cloud, Sunshine, Tmax, and Tmin (1954–1998)

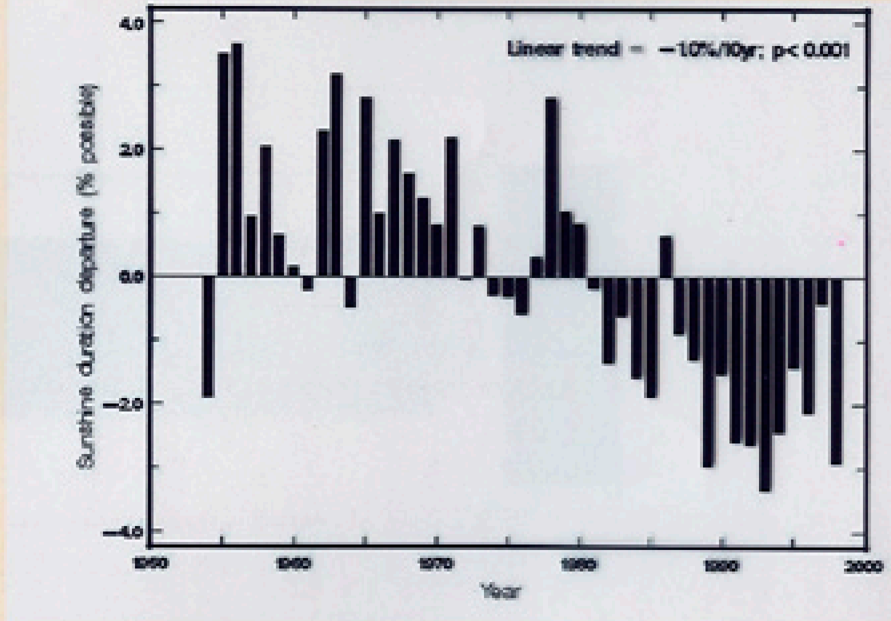


Retrospective on Cooperative Research Efforts Between the Chinese Academy of Sciences and DOE's Carbon Dioxide Information Analysis Center (CDIAC): 1984–2003

Trends in Annual Mean Sunshine Duration (1954–1998)



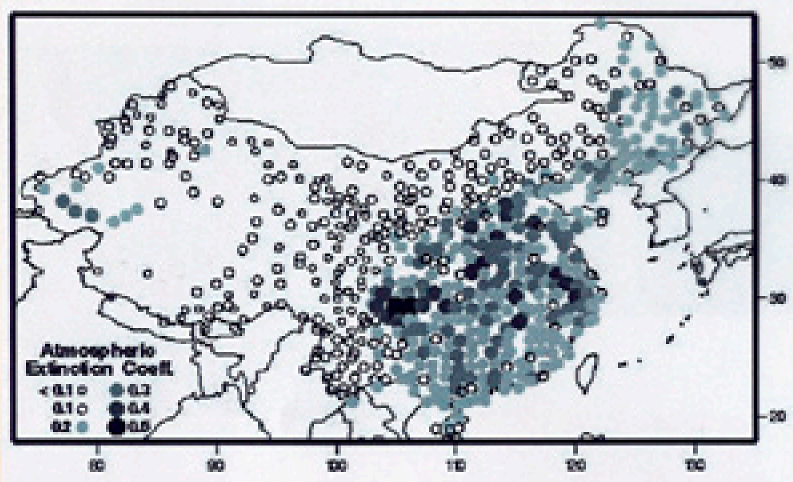
Departures in All-China Annual Mean Sunshine Duration (1954–1998)



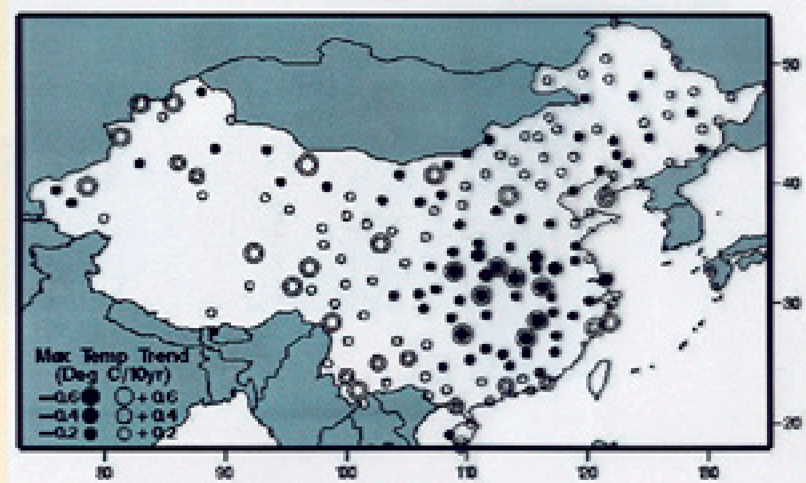
From Kaiser and Qian (2002)

Retrospective on Cooperative Research Efforts Between the Chinese Academy of Sciances and DOE's Carbon Dioxide Information Analysis Center (CDIAC): 1984–2003

Aerosol Extinction Coefficient (km^{-1}) averaged for the period 1981–1998



Trends in summer (JJA) mean daily Maximum Temperature (1954–1998)



From Kaiser and Qian (2002)

In Summary.......

The DOE-CAS Joint Research Agreement has been very successful, and CDIAC has benefited greatly from being a part of it.

CDIAC's participation has allowed us and the joint agreement program to make available some excellent data and information products.

These products have been in great demand by the global-change research community, and have been very useful in several open-literature publications.

The original China instrumental climate data made available by CAS to CDIAC provided the means and incentive for much continued research into China climate change. Myself and others are very grateful for this opportunity. Without the original CAS data, several publications over recent years by U.S. researchers probably would not have been produced.